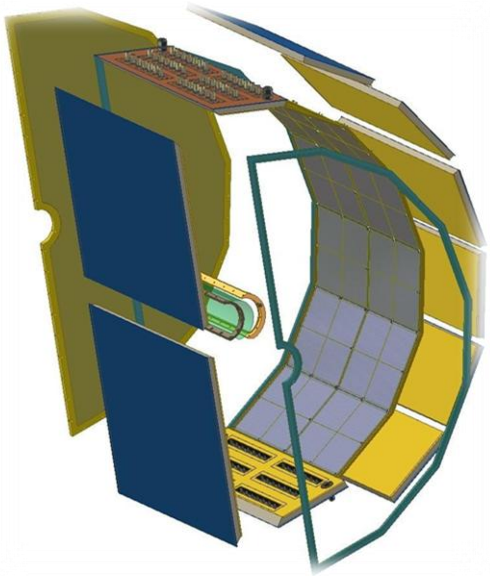
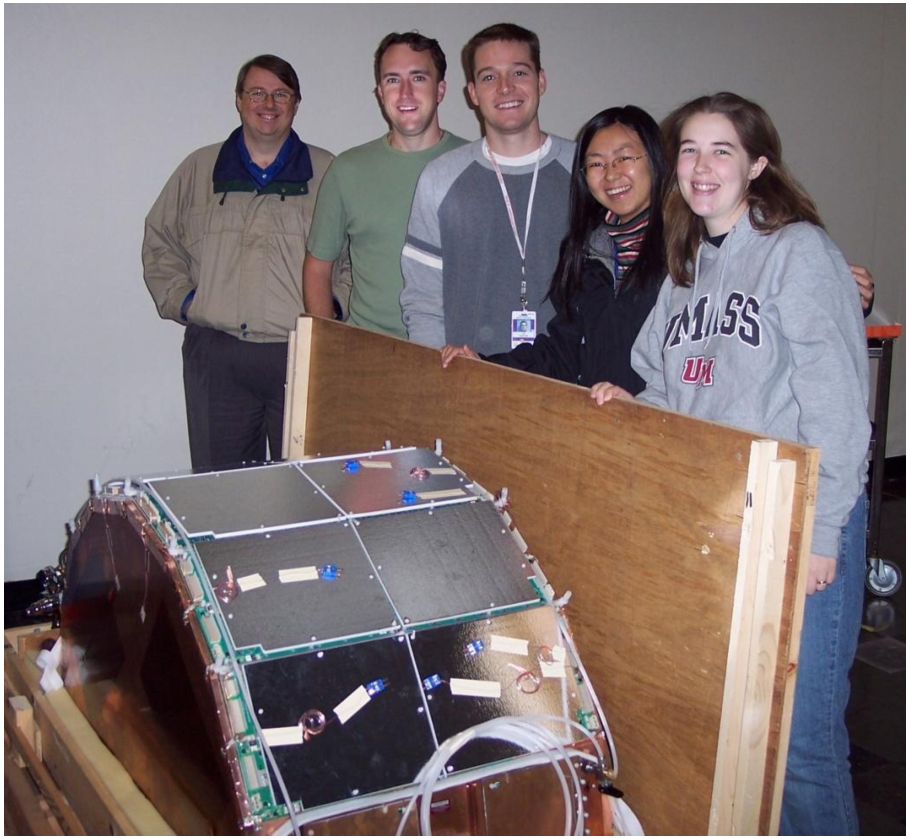
Hadron Blind Detector implementation during PHENIX Run-10





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On behalf of the PHENIX Collaboration

HBD Group

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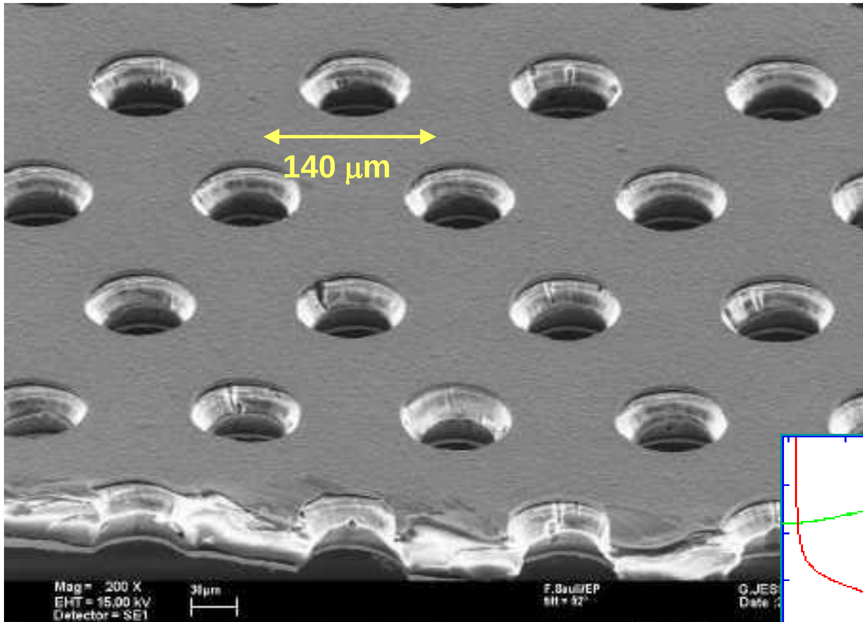
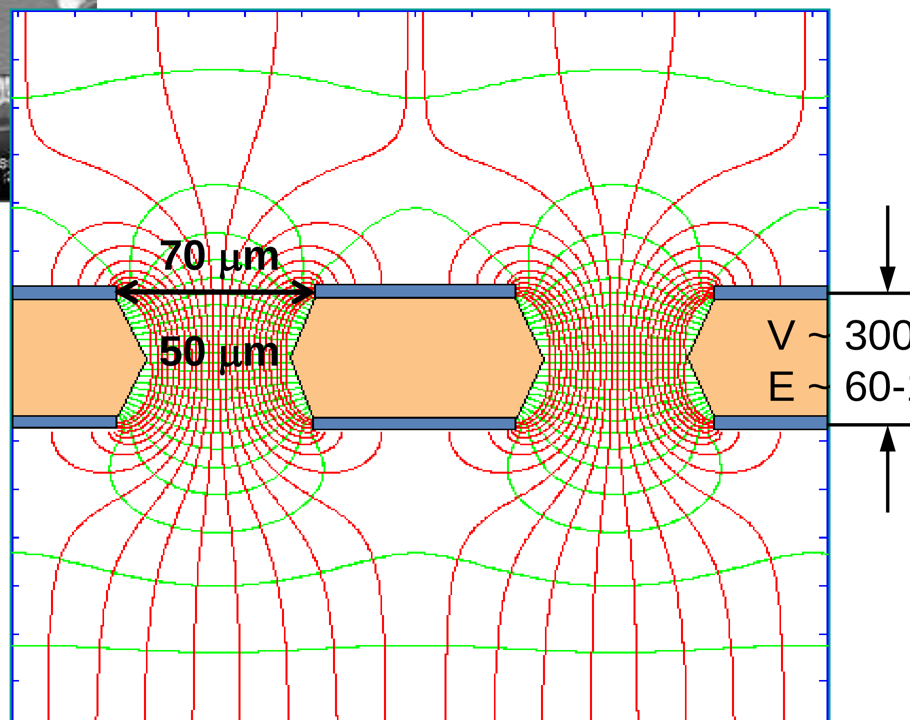
Gas Electron Multiplier (GEM)



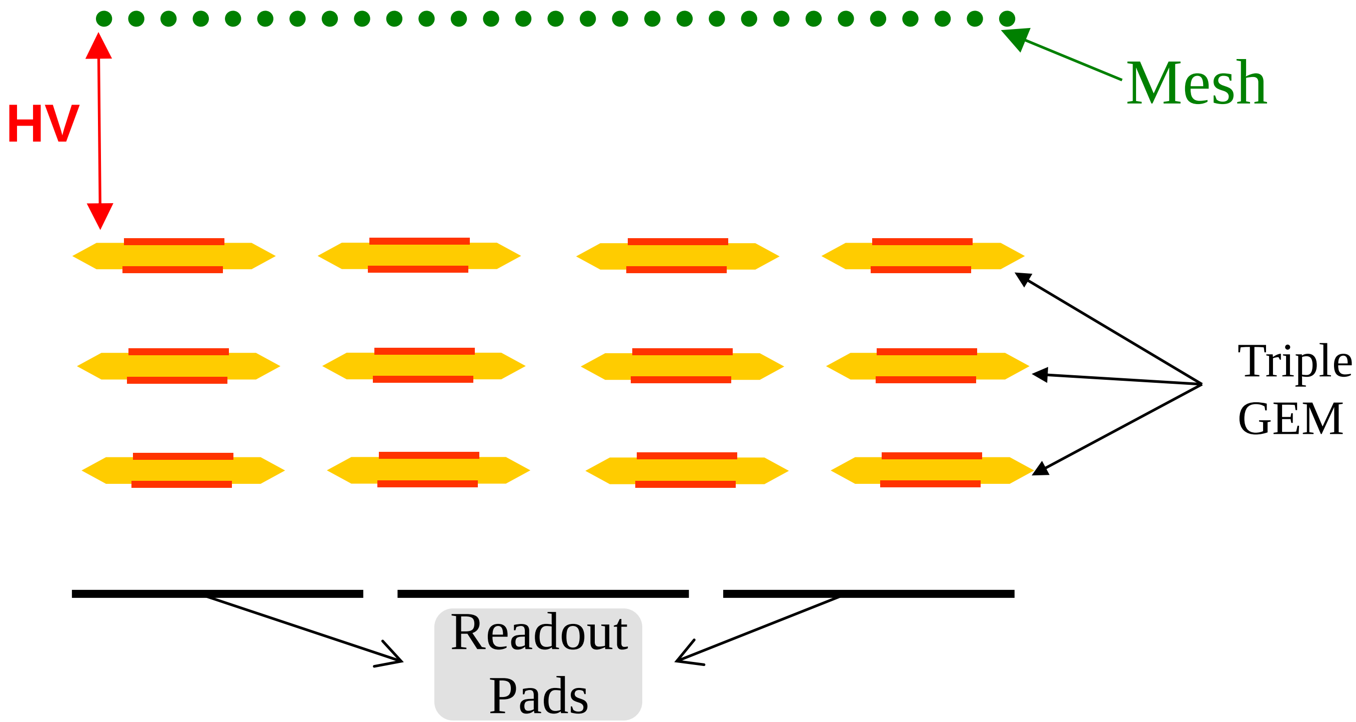
- Invented by F. Sauli at CERN (NIM A386 (1997) 531-534)
- Insulating film (Kapton) sandwiched between layers of metal (Cu, Au)
- HV creates strong field so that an avalanche can occur inside the holes



Gas Gains ~ 10-20 / GEM foil

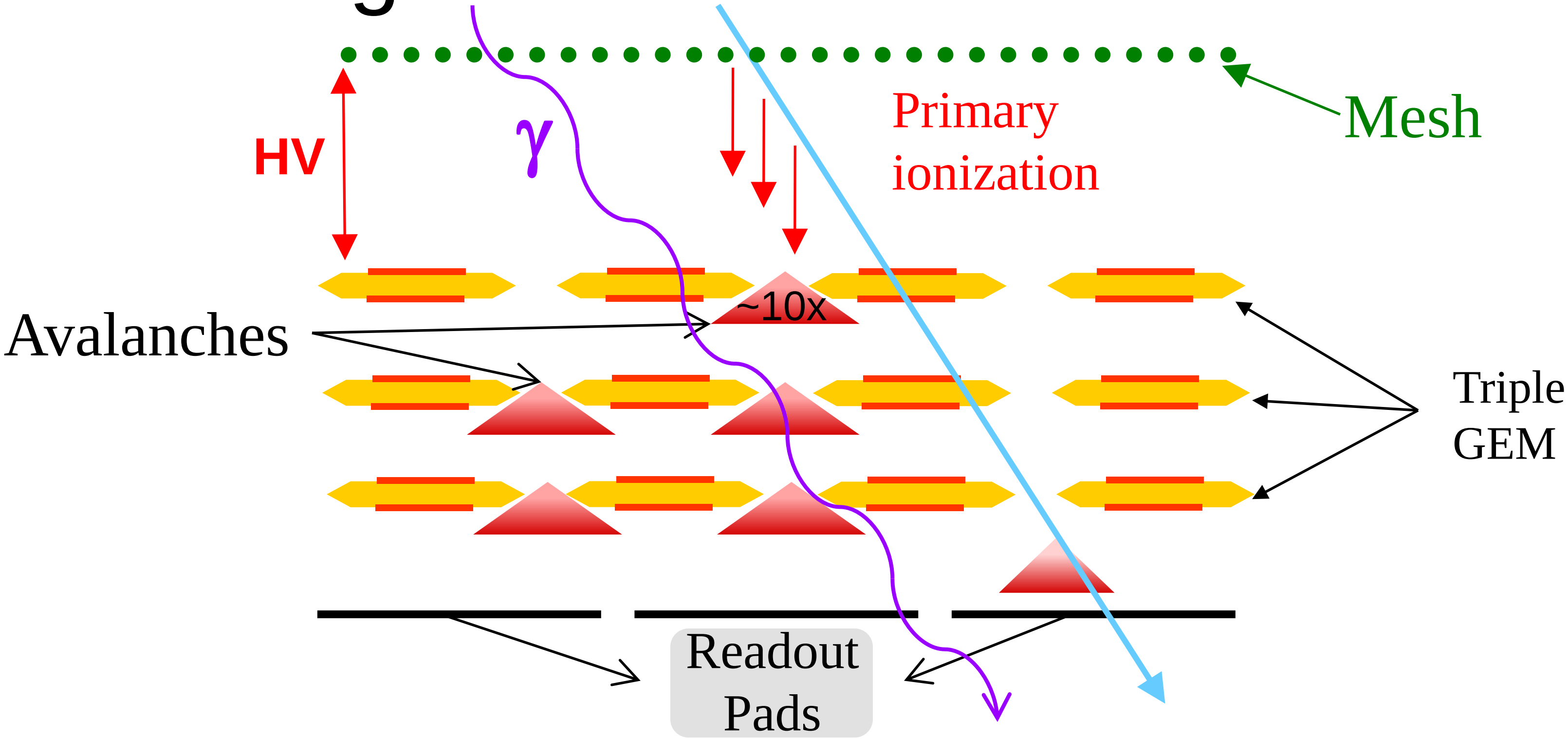
~ 10^3-10^4 or higher in triple-GEM configuration

Making a GEM detector Hadron Blind



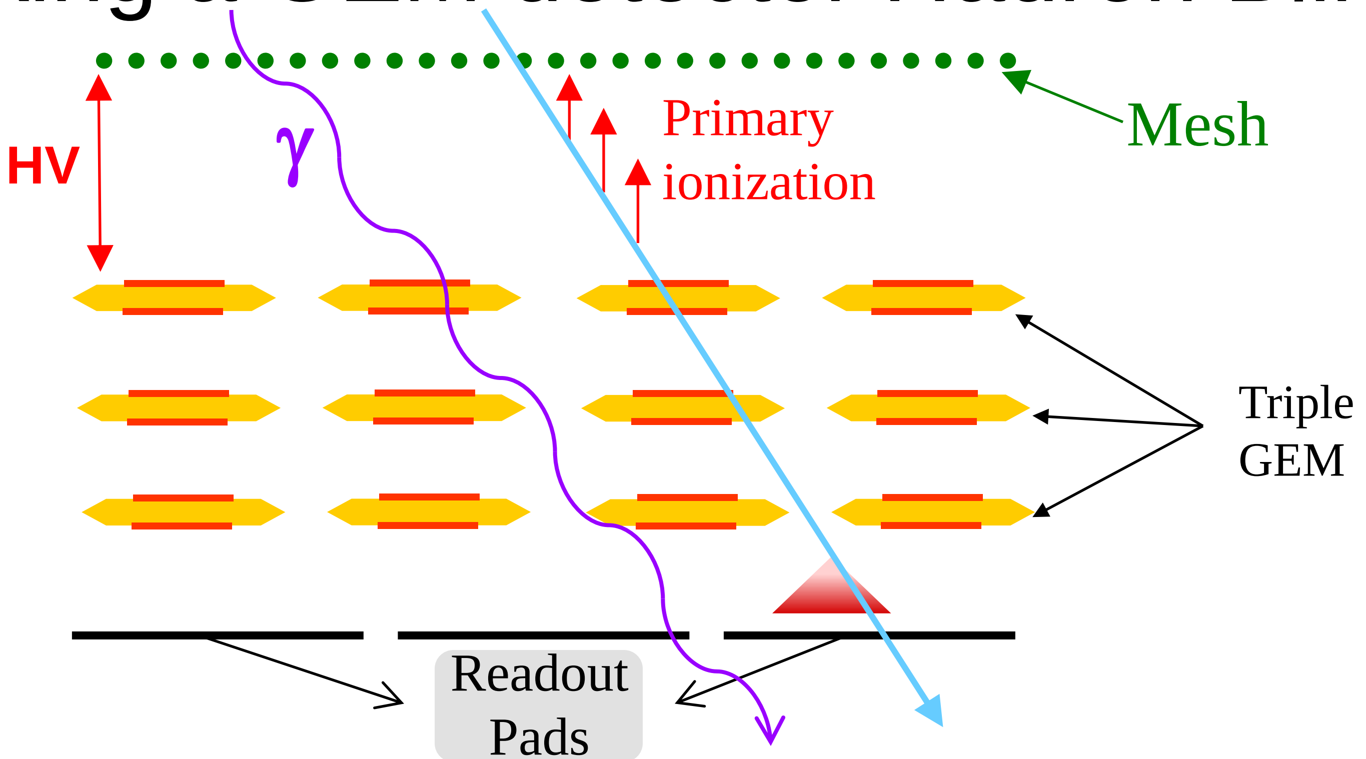
- Triple GEM stack with wire mesh and Readout Pads

Making a GEM detector Hadron Blind



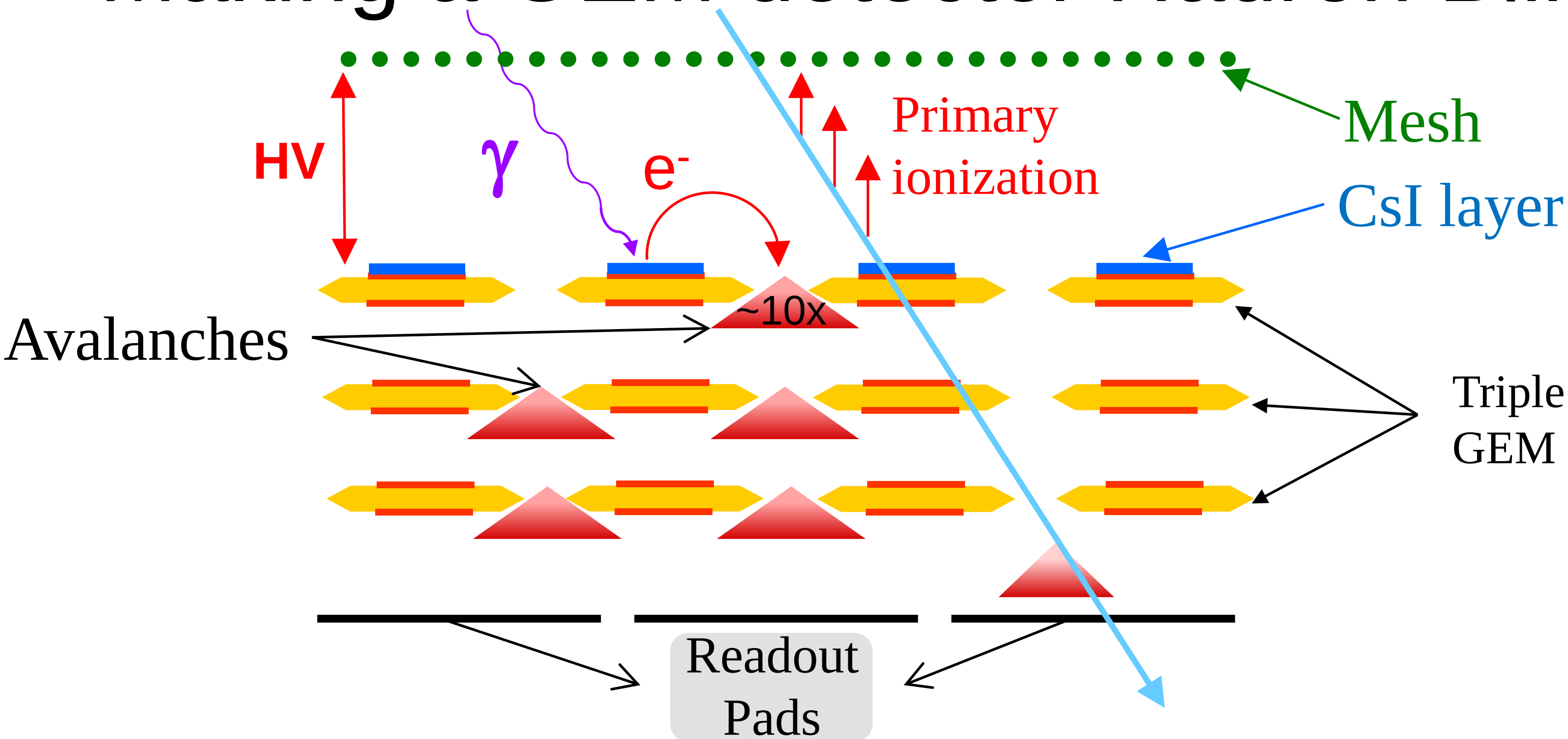
- Triple GEM stack with wire mesh and Readout Pads
- Ionization from charged particles avalanche and charge is collected on Pads

Making a GEM detector Hadron Blind



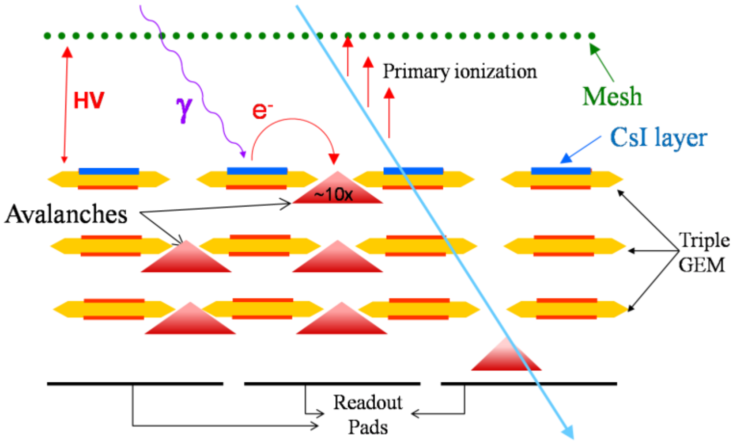
- Apply reverse-bias voltage on mesh-GEM → primary ionization drift away from GEM

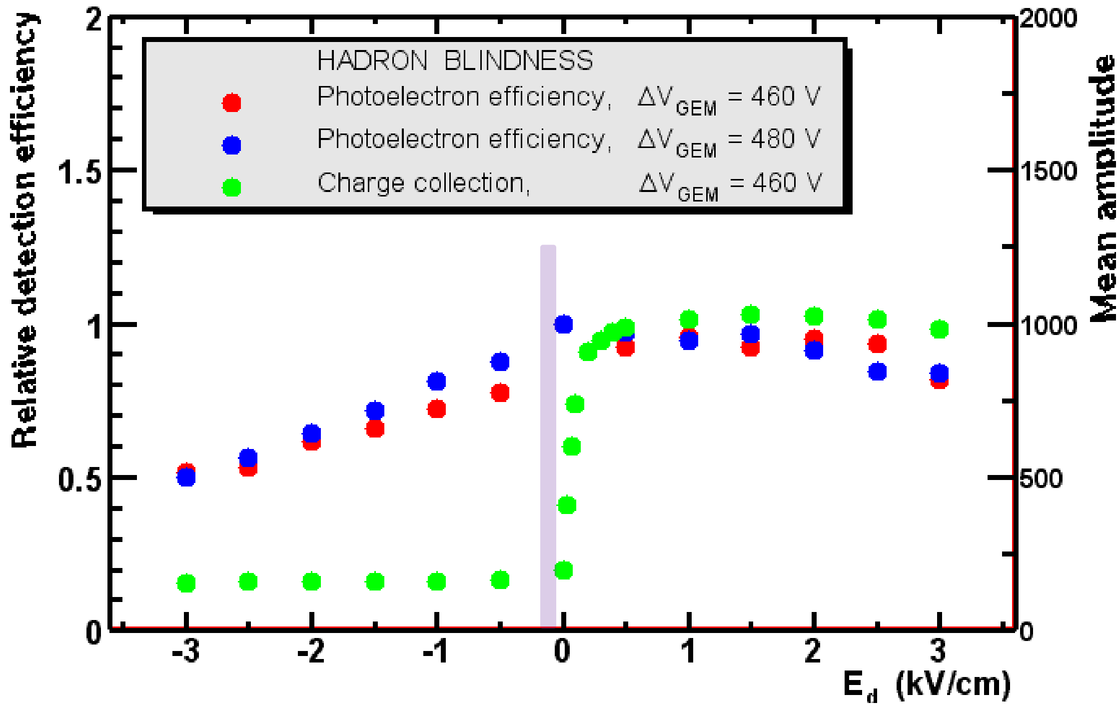
Making a GEM detector Hadron Blind



- Apply reverse-bias voltage on mesh-GEM → primary ionization drift away from GEM
- Deposit photocathode (CsI) on top GEM → UV photons produce photoelectrons from the CsI photocathode
  - Photoelectrons avalanche in the holes, charge collected by Readout Pads.
  - Triple GEM stack yields a gain of a few x 10^3

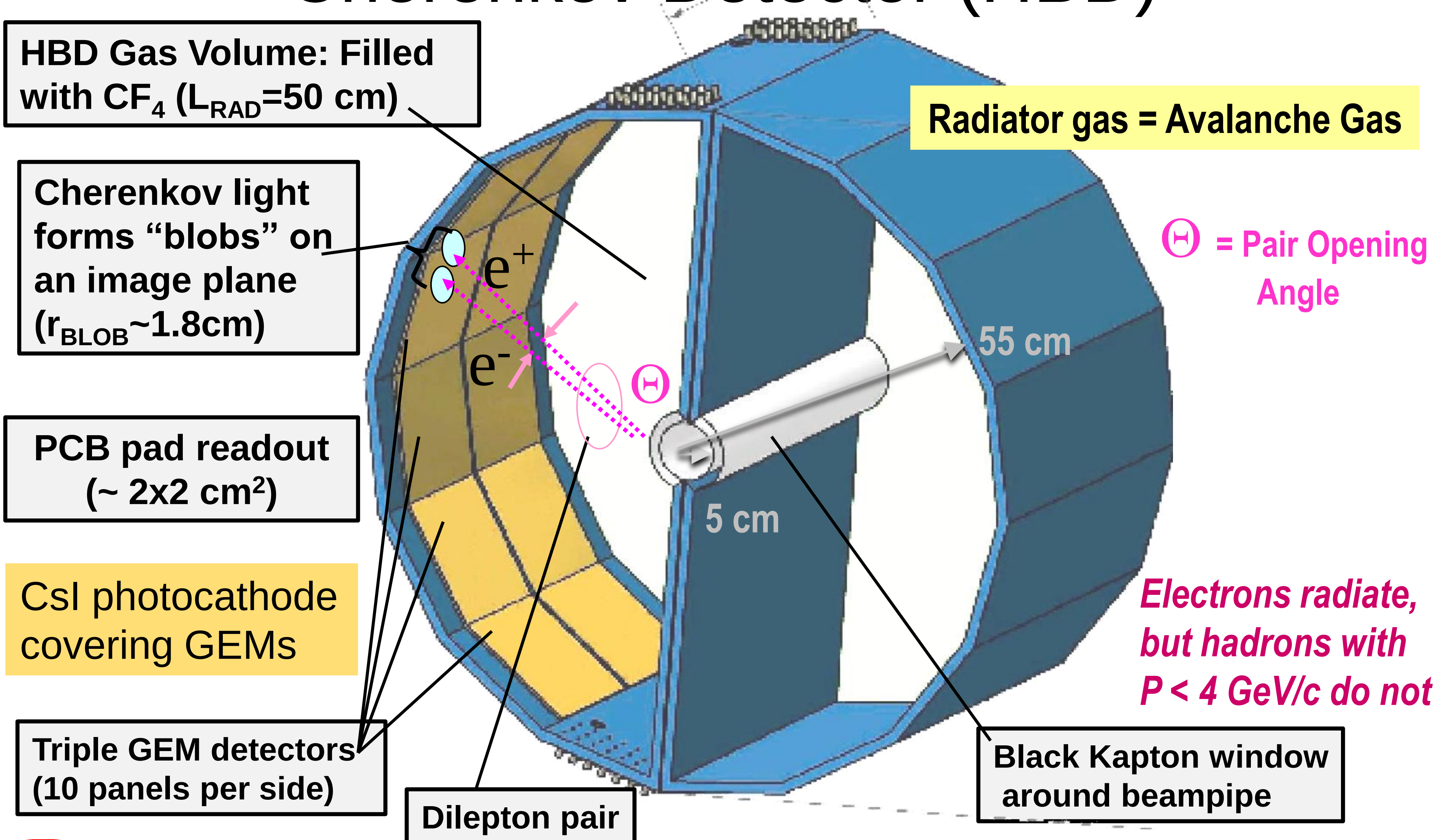
The Degree of Hadron Blindness



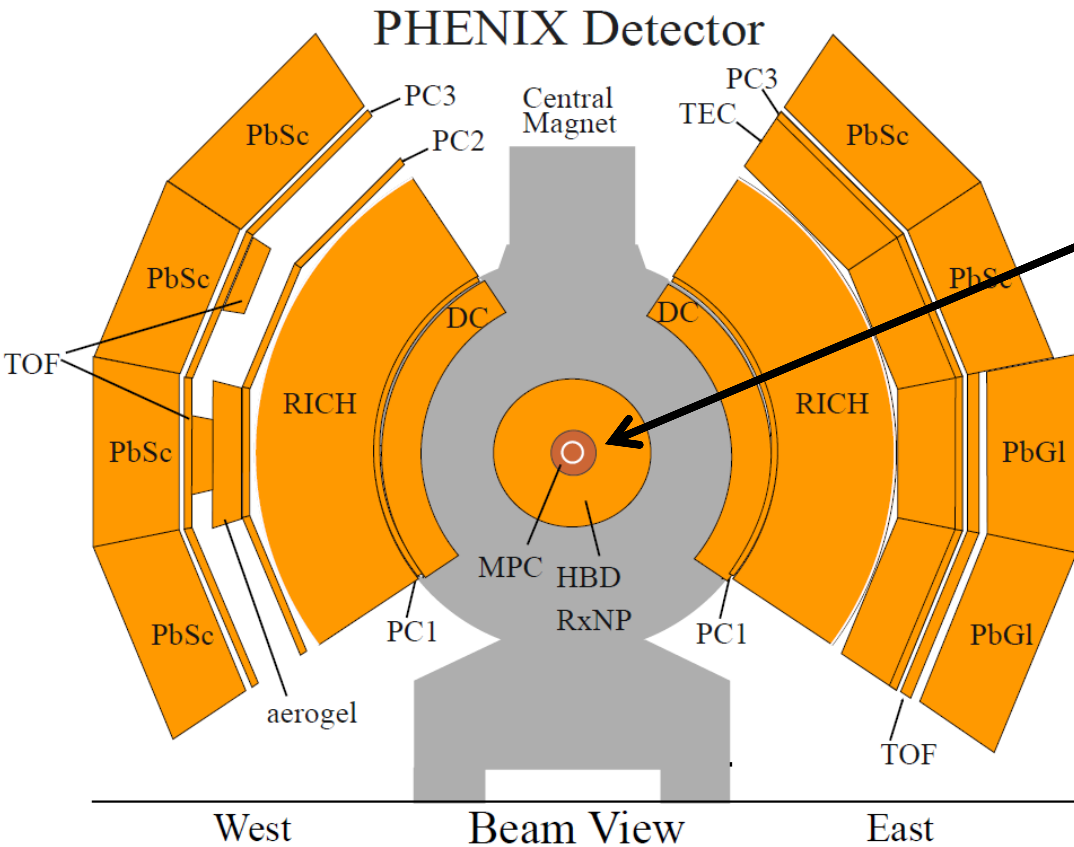


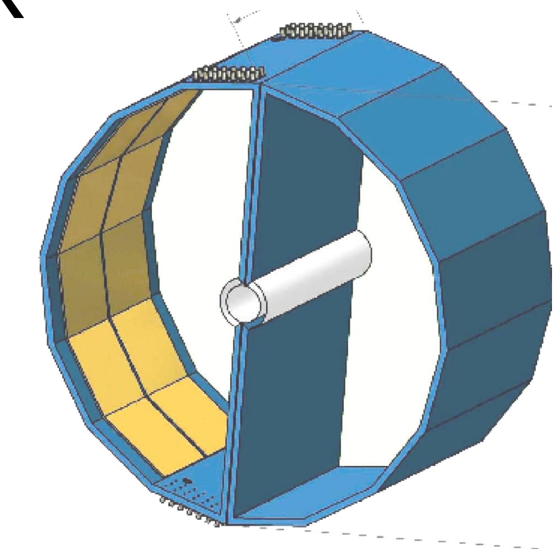
- At slightly negative E_d, photoelectron detection efficiency is preserved while charge collection is largely suppressed.

Proximity Focused Windowless Cherenkov Detector (HBD)



HBD in PHENIX

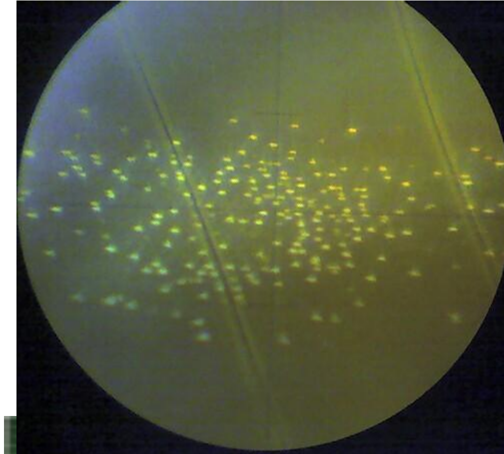


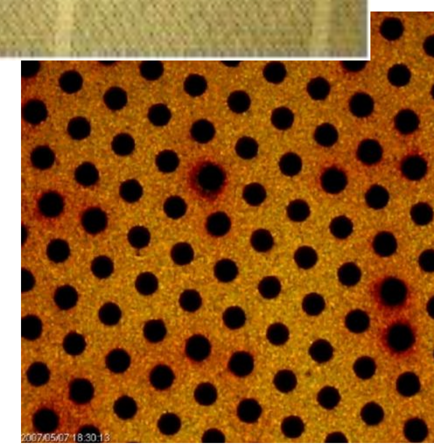


- Backgrounds due to low momentum electrons from Dailtz pairs & conversions can be reduced with HBD detection of electrons

HBD History

- Fall 2006 – installed in PHENIX for Run-7 (2006-07).
  - HBD's GEM foils were damaged due to severe HV problems
    - Minor GEM sparks induced damaging mesh to GEM sparks.
    - A spark would induce more sparks in other modules due to a copious production of photons from original spark.
- Rebuilt & installed for Run-9 (Feb. – July' 09)
  - Built HBD-East using time consuming "test, test, and install method".
  - Built HBD-West using M. Durham's Rapid Assembly Method.



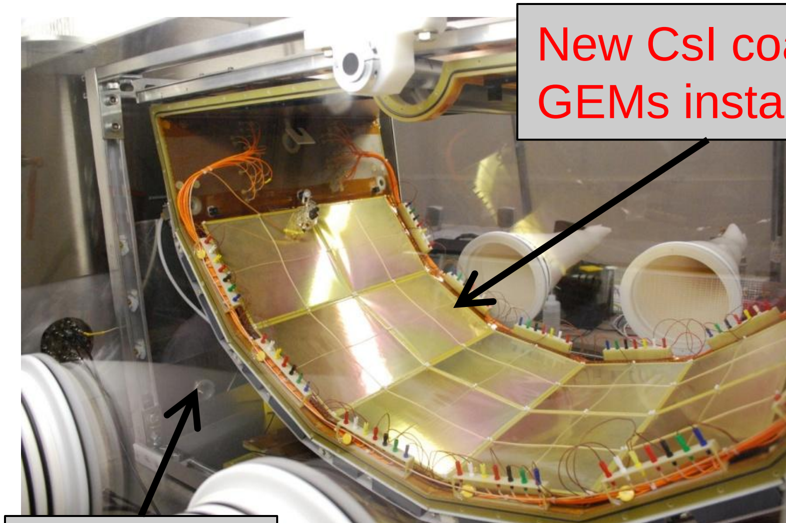


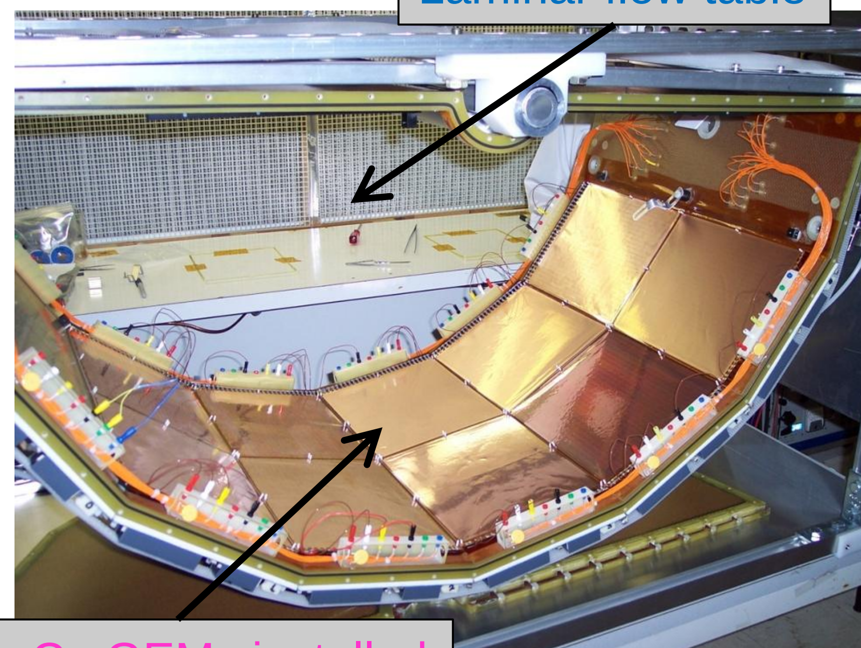
HBD History …

- HBD-West had no major problems during Run-9
- HBD-East Problems during Run-9:
  - Mesh-GEM short in 1 module (early in run)
    - Disabled module ES1.
  - Another module had deteriorating performance.
  - Sparking resulting in trips cause subpar data collection.
- Decision to rebuild HBD-East
  - Known difference in assembly method of East/West arms.
  - Deterioration in performance continuing into Run-10 a possibility.
  - Time scale to rebuild was sufficient.

Rebuilding of HBD-East

- M. Durham's Rapid Assembly Method.
  - Individual GEMs: clean, condition w/HV, test.
  - Assemble bottom & middle GEMs in an easy to access, clean environment (adjacent to laminar flow table).
  - Install top GEMs (CsI coated) in Nitrogen filled glove box.
  - Seal HBD vessel, then test GEM stacks.



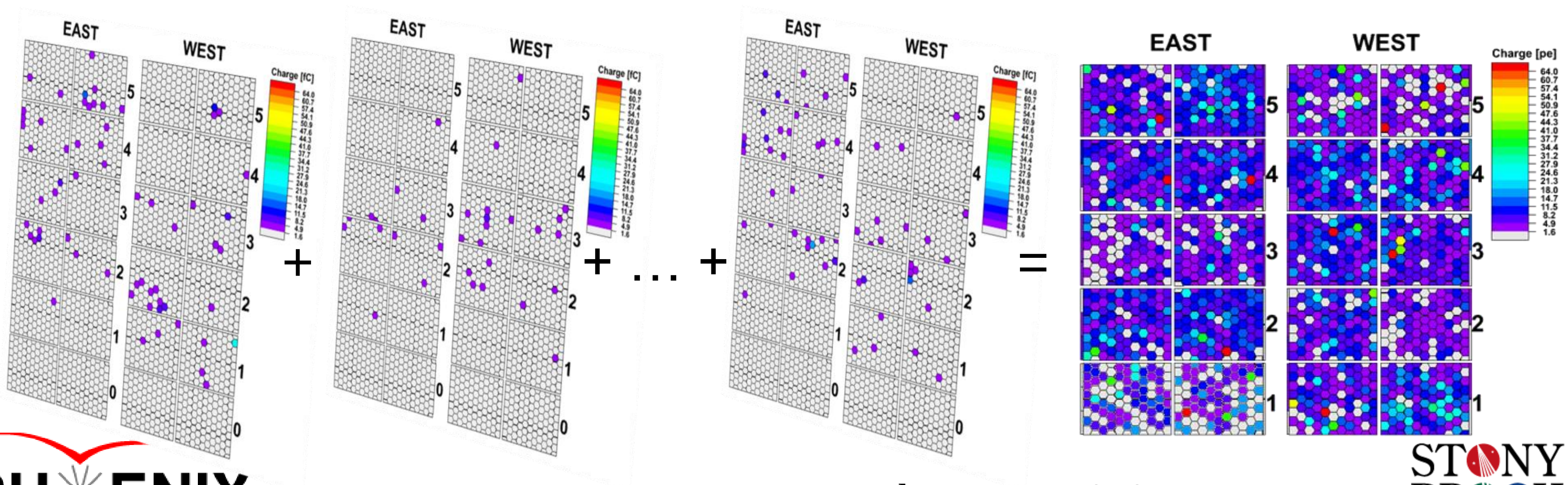


Problem with HBD module EN2

- Testing of HBD-East showed that GEM stack EN2 could not hold the nominal operating voltage
  - Each individual GEM able to maintain a voltage exceeding nominal operating voltage.
  - Possibly due to small dent in a GEM.
  - Workaround solution adopted.
    - Revert voltage divider to older design, which maintains a lower voltage
    - Eventually shorts developed leading to trips… EN2 was disabled.
- Other attempts at fixing EN2 have failed
  - Currently EN2 is disabled
  - 5% acceptance loss

Creating Au+Au Events from p+p events

- HBD is very efficient at determining tracks from p+p events.
- Instead of using Monte Carlo, use real data by accumulating many p+p events to emulate one Au+Au event.
  - p+p tracks for each individual events are well determined.
  - HBD reconstruction will be less efficient in determining Au+Au tracks due to overlapping of tracks.
  - Obtain electron identification in Au+Au collisions by comparing "Accumulated" Au+Au events to known p+p reconstructions.



Conclusions

- Rapid Assembly Method proved successful.
- HBD-East rebuild improved performance
  - Module EN2 disabled, 5% loss of acceptance .
  - Remaining HBD-East modules working as expected.
- p+p event accumulator will allow determination of the HBD’s electron identification efficiency.
- Due to the HBD, PHENIX has the added benefit of suppressing Dalitz pairs and photon conversions.
- For more on HBD, stick around for Sky Rolnick’s *Chiral Symmetry Restoration using HBD* following this talk.

Extras

HBD Detector Parameters

Acceptance	$\lvert\eta\rvert \leq 0.45$, $\Delta\phi = 135^{o}$
GEM size (ϕ,z)	23 x 27 cm^2
Segmentation	26 strips (0.80 x 27 cm) 2 strips (0.65 x 27 cm)
Number of detector modules per arm	10
Frame	5 mm wide, 0.3mm cross
Hexagonal pad size	a = 15.6 mm
Number of pads per arm	960
Dead area within central arm acceptance	6%
Radiation length within central arm acceptance	box: 0.92%, gas: 0.54%, preamps+sockets: 0.66% Total: 2.12%
Weight per arm (including accessories)	<10 kg